UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

June 1, 2015

Reply To
Attn Of: OEA-095

MEMORANDUM

Subject: Pend Oreille River Model Simulations of Point Source Impacts

From: Ben Cope, Environmental Engineer
Office of Environmental Assessment

To: Brian Nickel, Environmental Engineer
Office of Water

This technical memorandum provides the results of model simulations per your request on April 24, 2015. We have employed the existing, calibrated CE-QUAL-W2 model for the Pend Oreille River for this analysis (Cadmus et al, 2011). We also contacted Chris Berger of Portland State University to obtain the custom programs used to post-process the model output in past scenario analyses. This memorandum provides the results of two scenarios: an updated baseline simulation (existing conditions) and a future scenario with proposed limitations for the wastewater treatment plant in Sandpoint, Idaho.

Model Documentation

Prior reports prepared for the Pend Oreille River modeling in Idaho include:

- Annear et al. (2006) - Idaho Pend Oreille River Model: Model Development and Calibration
- Annear et al. (2007) - Idaho Pend Oreille River Model: Model Scenario Simulations
- The Cadmus Group, Inc. and Scott Wells and Associates (2010) – Pend Oreille River Phosphorus Load Allocation Analysis: Quality Assurance Project Plan
- Wells and Berger (2010) - Review of Corps of Engineers Revisions to the Pend Oreille Model
- The Cadmus Group and Scott Wells and Associates (2011) - Pend Oreille River Phosphorus Load Allocation Analysis: Model Calibration Report
- The Cadmus Group and Scott Wells and Associates (2011) - Pend Oreille River Phosphorus Load Allocation Analysis: Scenarios Report

This document reports the results of 2 scenarios to evaluate the impact of discharges from the Sandpoint, Idaho, wastewater treatment plant.

Modeling Scenarios

The existing conditions model setup is identical to the previous setup (Cadmus et al, 2011) with the exception of the assumed discharges at three municipal point sources (Sandpoint, Priest River, and Dover). These discharges were modified based on updated monitoring information to better reflect current conditions. For the Sandpoint scenario, all model inputs were identical to the existing condition setup with the exception of the flow, BOD5, and TP of the Sandpoint treatment plant. These were adjusted to the proposed permit limit values. The impact of the proposed Sandpoint facility permit, relative to the prior permit, is estimated as difference in downstream water quality between the two scenarios.

Modeling scenarios were run for specified flow rates, BOD concentrations and nutrient concentrations for the wastewater treatment plants within the modeled reach. Model boundary conditions, such as meteorological inputs, tributary inflows, and the upstream boundary, were same as those used for year 2009 except for the dischargers.

Scenario 1: Existing Conditions

All model inputs are unchanged from the existing Pend Oreille River model (Cadmus et al., 2011), except as follows:

City of Sandpoint WWTP

- Effluent flow: 3.0 mgd (constant)
  - Basis: Design flow as stated in previous fact sheet and permit application
- BOD_5: 30 mg/L (constant)
  - Basis: Existing permit limit
- Total Phosphorus : 2.41 mg/L (constant)
  - Basis: Concentration used in reasonable potential analysis for 2014 draft permit (average concentration March 2002 – March 2012).

City of Priest River WWTP

- NO2 + NO3: 14.3 mg/L
  - Average concentration measured between 2/2012 and 4/2015.
- NH3: 0.76 mg/L
  - Average concentration measured between 2/2012 and 4/2015.

City of Dover WWTP

- NO2 + NO3: 6.5 mg/L
  - Concentration measured on 3/31/15 (1 sample).

- NH3: 0.099 mg/L
    - Average concentration measured between 1/2012 and 12/2014.

Scenario 2: Draft Permit Conditions

All model inputs will be unchanged from the "Existing Conditions" scenario, except as follows:

City of Sandpoint WWTP

- Effluent flow: 5.0 mgd (constant)
    - Basis: Design flow as stated in most recent permit application
- BOD_5: 30 mg/L (constant)
    - Basis: Proposed permit limit (technology-based)
- Total Phosphorus:
    - July 1 – September 30: 1.46 mg/L
    - October 1 – June 30: 2.30 mg/L
        - Basis: Proposed permit limits

A listing of discharge values for other parameters is included in tables 5 through 7 of the 2011 scenario report (Cadmus Group et al., 2011).

CBOD-P, or the phosphorus associated with a specific CBOD group (there was a CBOD group associated with each WWTP), was modeled as a separate constituent. CPOD-P was estimated from the specified total phosphorus concentration (TP) and ortho-phosphorus concentration (PO4P) using:

$$\text{CBOD-P} = \text{TP} - \text{PO4P}$$

For the Sandpoint phosphorus scenarios, the fraction of TP in the form of PO4P in the original model (Cadmus et al., 2011) was 68%. This ratio was to calculate the CBOD-P in both scenarios.

Results

Scenarios were compared using time series and longitudinal profiles of pH, dissolved oxygen (DO), total phosphorus (TP), ammonia nitrogen (NH3-N), algae (chlorophyll a) and periphyton (dry-weight biomass). Depth averaged concentrations over the full water column were compared for pH, DO, TP and NH3-N. Chlorophyll a concentrations corresponded to the predicted values at a depth of 1 meter. For periphyton, the average concentration in the upper 10 meters was used. Below a depth of 10 meters periphyton productivity dropped off considerably. Time series were compared at the outflow of Albeni Falls dam, 10 km downstream of the model's upstream boundary, and 35 km downstream of upstream boundary. Longitudinal profiles were compared for July 3rd at 4 pm (Julian Day 184.625). This date was chosen because it was a warm, summer day with relatively high productivity.

Table 1. Locations and model segments of time series output.

Location	River Mile	Model Segment
10 km downstream of upstream boundary	112.6	42
35 km downstream of upstream boundary	97.5	148
Outflow from Albeni Falls Dam	90.18	198

Average predicted concentrations of the time series output are listed in Table 2 through Table 7, including average concentrations for the entire year and July-September period.

Table 2. Average model predicted concentrations 10 km downstream of upstream boundary for the entire year.

	D. O. mg/l	PO4-P mg/l	NH4-N mg/l	TP mg/l	pH	Periphyton Biomass gD/m^2	Phytoplankton Chlorophyll a mg/l
Scenario 1	9.78	0.0009	0.0102	0.0083	8.45	1.7	1.7
Scenario 2	9.81	0.0011	0.0121	0.0085	8.46	2.0	1.7

Table 3. Average model predicted concentrations 10 km downstream of upstream boundary for the July-September period.

	D. O. mg/l	PO4-P mg/l	NH4-N mg/l	TP mg/l	pH	Periphyton Biomass gD/m^2	Phytoplankton Chlorophyll a mg/l
Scenario 1	9.02	0.0008	0.0114	0.0063	8.38	3.1	1.6
Scenario 2	9.01	0.0008	0.0142	0.0064	8.38	3.3	1.6

Table 4. Average model predicted concentrations 35 km downstream of upstream boundary for the entire year.

	D. O. mg/l	PO4-P mg/l	NH4-N mg/l	TP mg/l	pH	Periphyton Biomass gD/m^2	Phytoplankton Chlorophyll a mg/l
Scenario 1	9.84	0.0009	0.0099	0.0082	8.42	1.0	1.5
Scenario 2	9.87	0.0010	0.0108	0.0084	8.44	1.1	1.6

Table 5. Average model predicted concentrations 35 km downstream of upstream boundary for the July-September period.

	D. O. mg/l	PO4-P mg/l	NH4-N mg/l	TP mg/l	pH	Periphyton Biomass gD/m^2	Phytoplankton Chlorophyll a mg/l
Scenario 1	8.51	0.0009	0.0118	0.0066	8.27	2.1	1.2
Scenario 2	8.49	0.0009	0.0139	0.0066	8.27	2.3	1.2

Table 6. Average model predicted concentrations at dam outflow for the entire year.

	D. O. mg/l	PO4-P mg/l	NH4-N mg/l	TP mg/l	pH	Periphyton Biomass gD/m^2	Phytoplankton Chlorophyll a mg/l
Scenario 1	9.93	0.0008	0.0091	0.0077	8.45	1.8	1.6
Scenario 2	9.97	0.0009	0.0100	0.0078	8.46	2.0	1.6

Table 7. Average model predicted concentrations at dam outflow for the July-September period.

	D. O. mg/l	PO4-P mg/l	NH4-N mg/l	TP mg/l	pH	Periphyton Biomass gD/m^2	Phytoplankton Chlorophyll a mg/l
Scenario 1	8.75	0.0004	0.0102	0.0058	8.38	2.9	1.5
Scenario 2	8.73	0.0005	0.0126	0.0058	8.38	3.0	1.5

Time series and a longitudinal plot for each variable and site location are provided in Figures 1-24. The plots are sequenced as follows: phytoplankton chlorophyll a, periphyton biomass, pH, dissolved oxygen, total phosphorus, and ammonia.

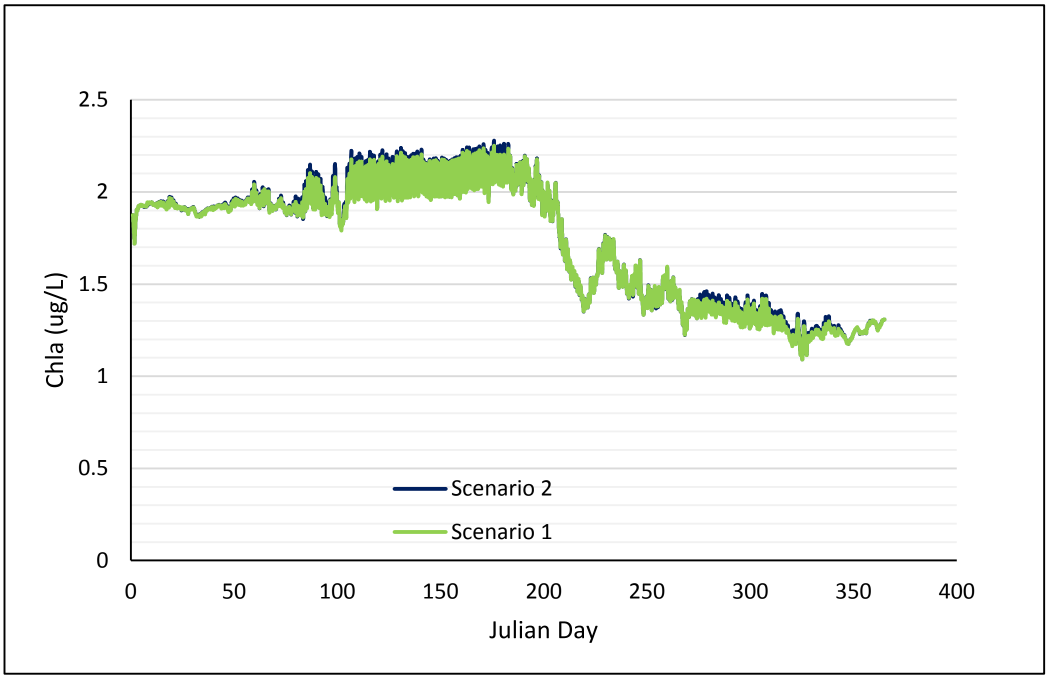

Figure 1. Model predicted phytoplankton chlorophyll a concentrations 10 km downstream of upstream boundary.

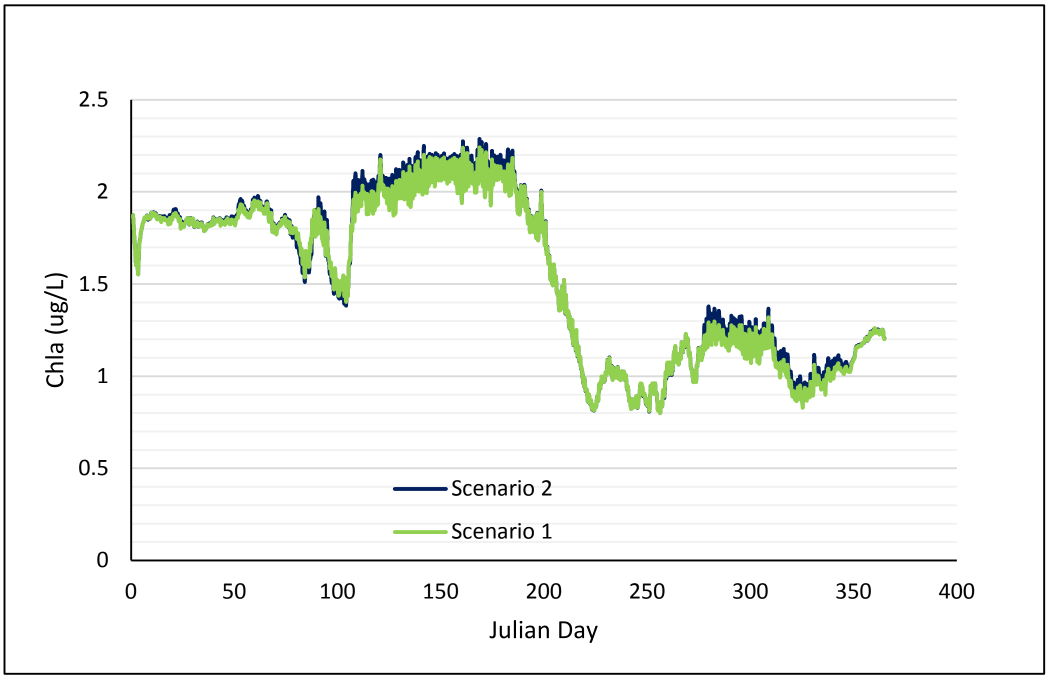

Figure 2. Model predicted phytoplankton chlorophyll a concentrations 35 km downstream of upstream boundary.

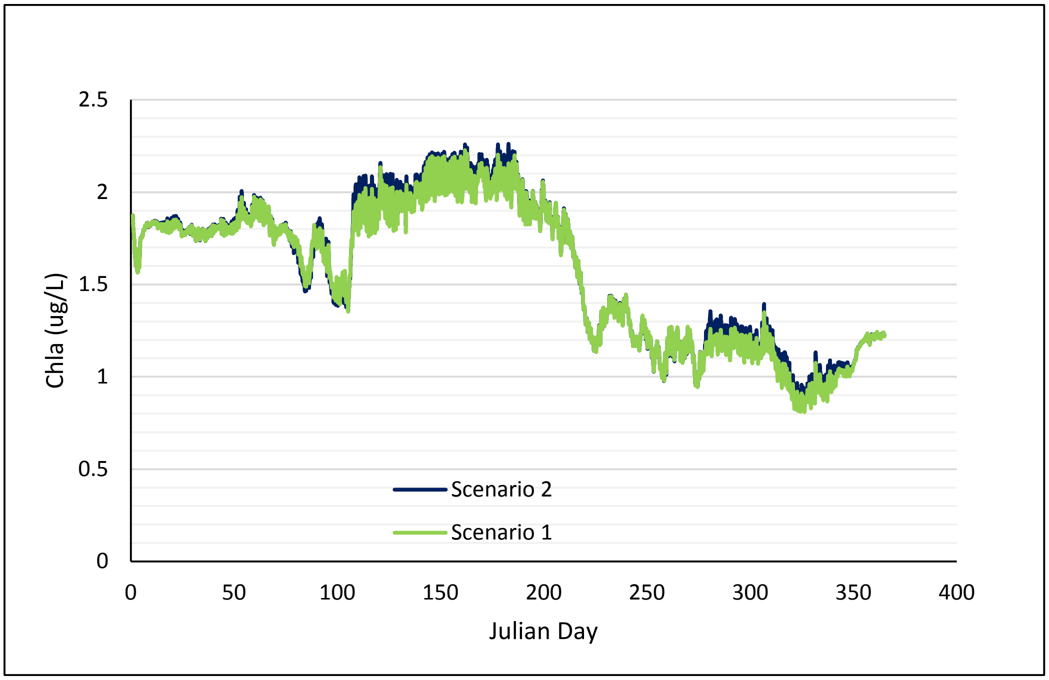

Figure 3. Model predicted phytoplankton chlorophyll a concentrations at Albeni Falls Dam.

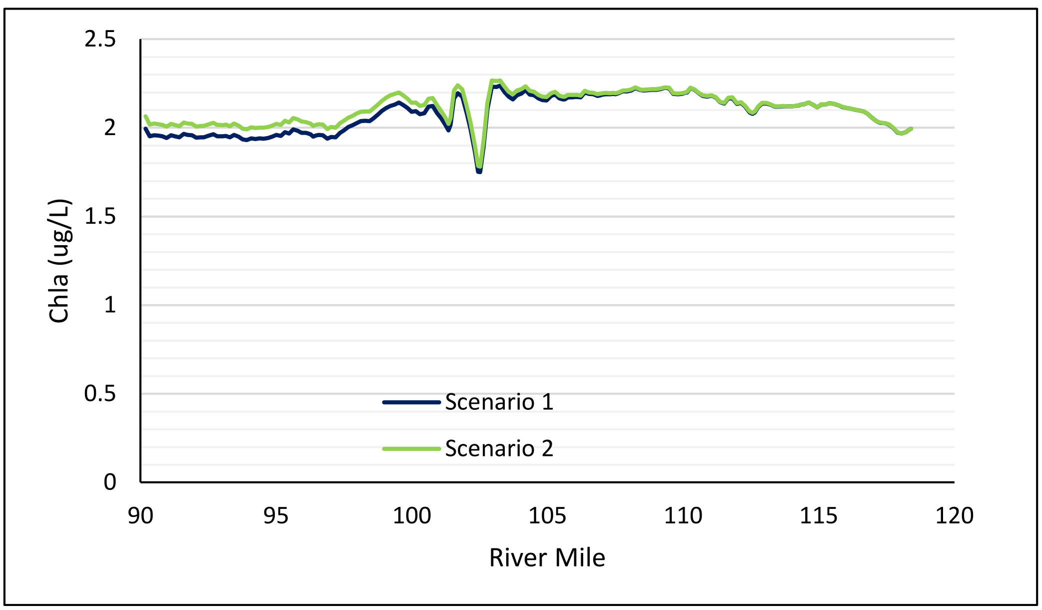

Figure 4. Longitudinal profile of phytoplankton chlorophyll a concentrations on July 3rd at 4 pm (Julian Day 184.625).

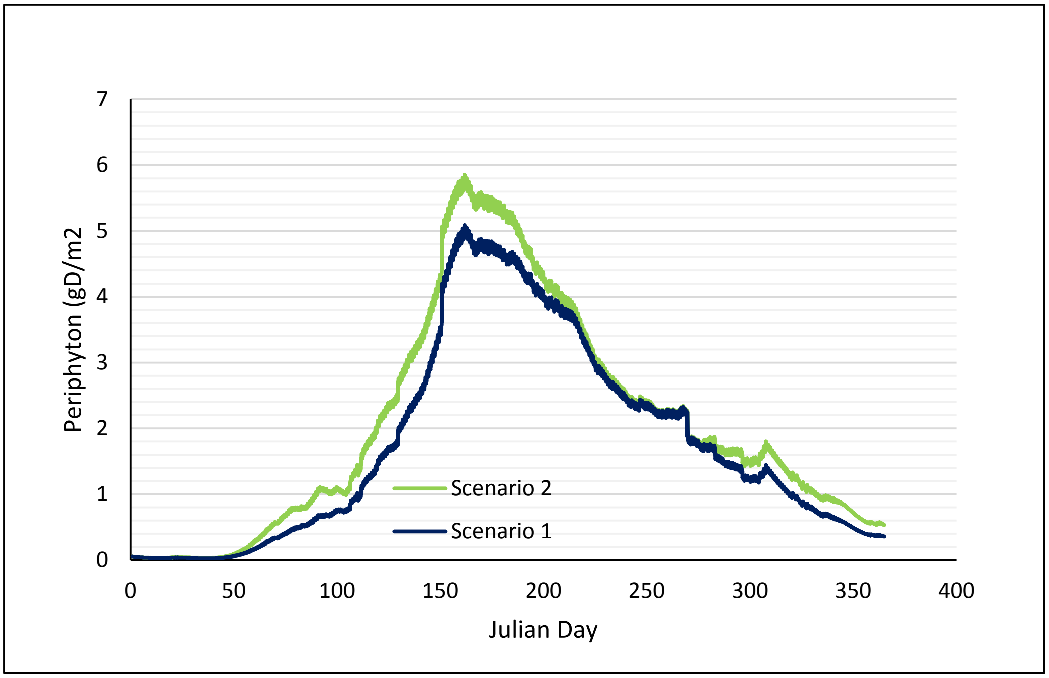

Figure 5. Model predicted periphyton biomass concentrations 10 km downstream of upstream boundary.

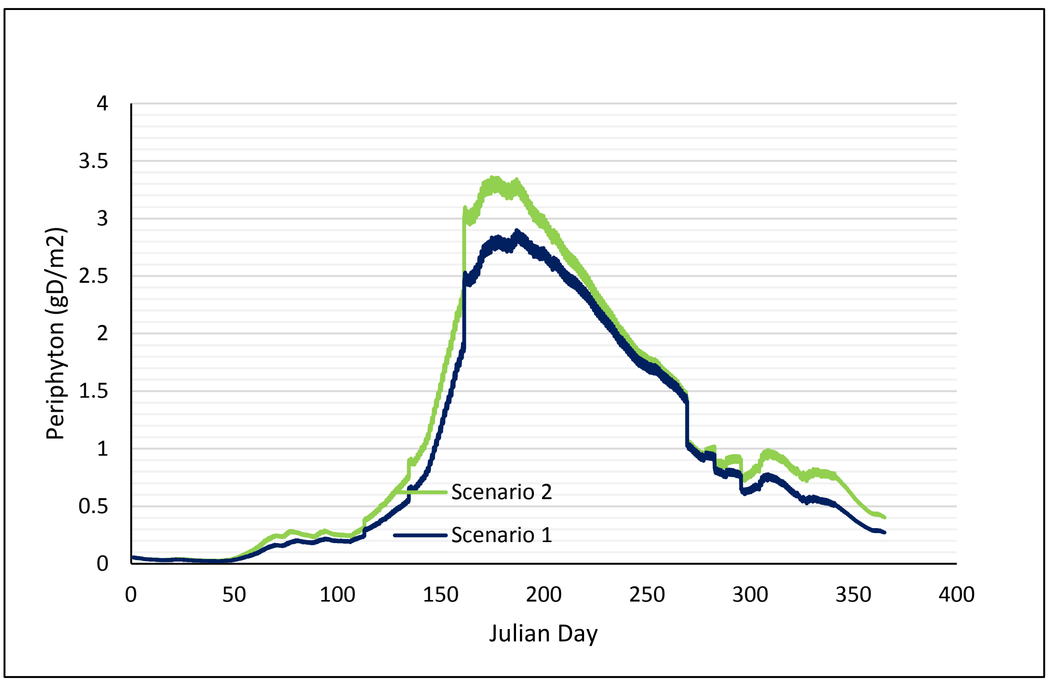

Figure 6. Model predicted periphyton biomass concentrations 35 km downstream of upstream boundary.

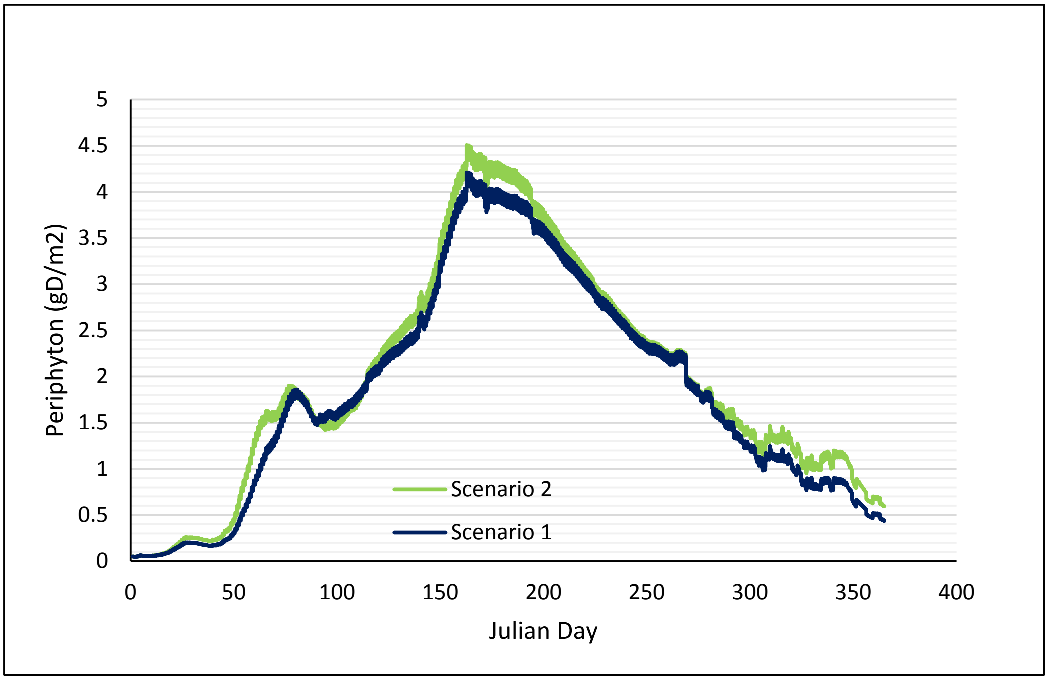

Figure 7. Model predicted periphyton biomass concentrations at Albeni Falls Dam.

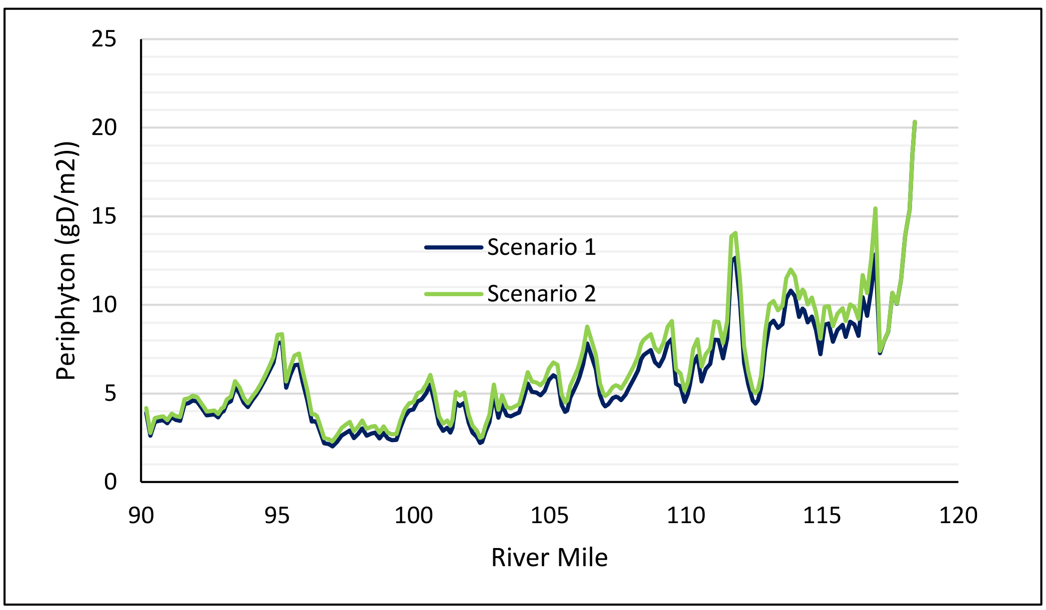

Figure 8. Longitudinal profile of periphyton biomass concentrations on July 3rd at 4 pm (Julian Day 184.625).

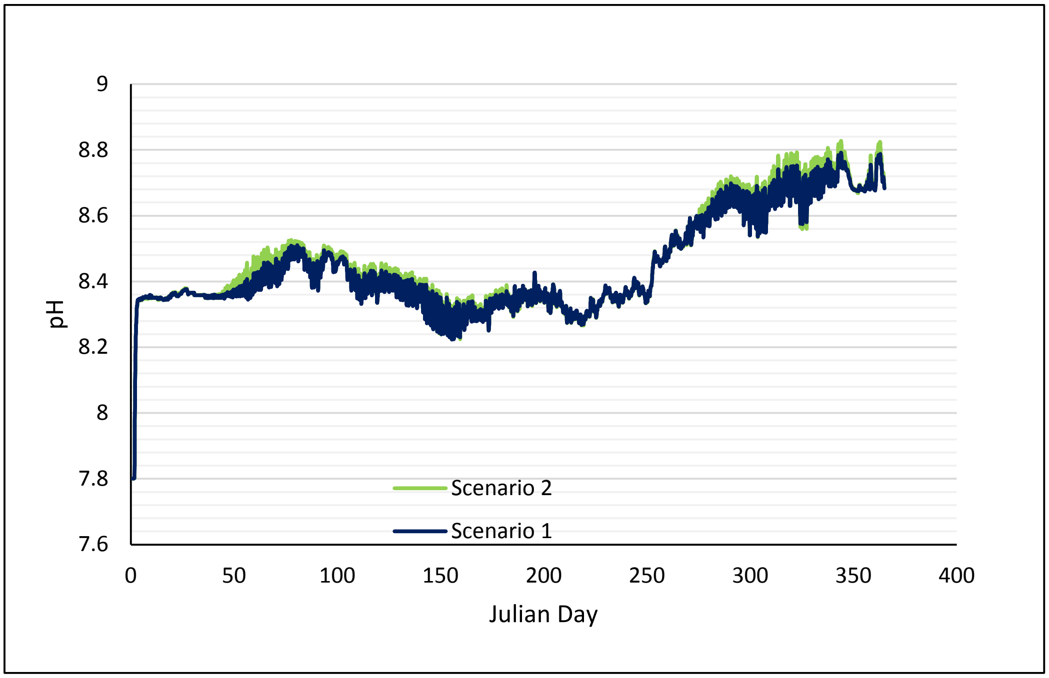

Figure 9. Model predicted pH 10 km downstream of upstream boundary.

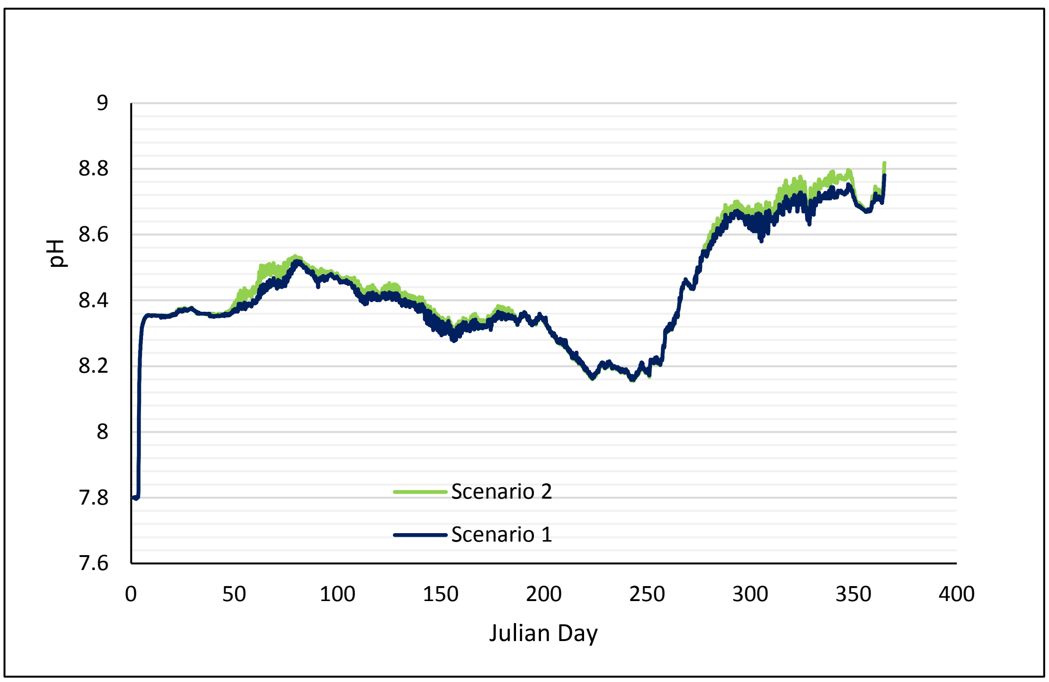

Figure 10. Model predicted pH 35 km downstream of upstream boundary.

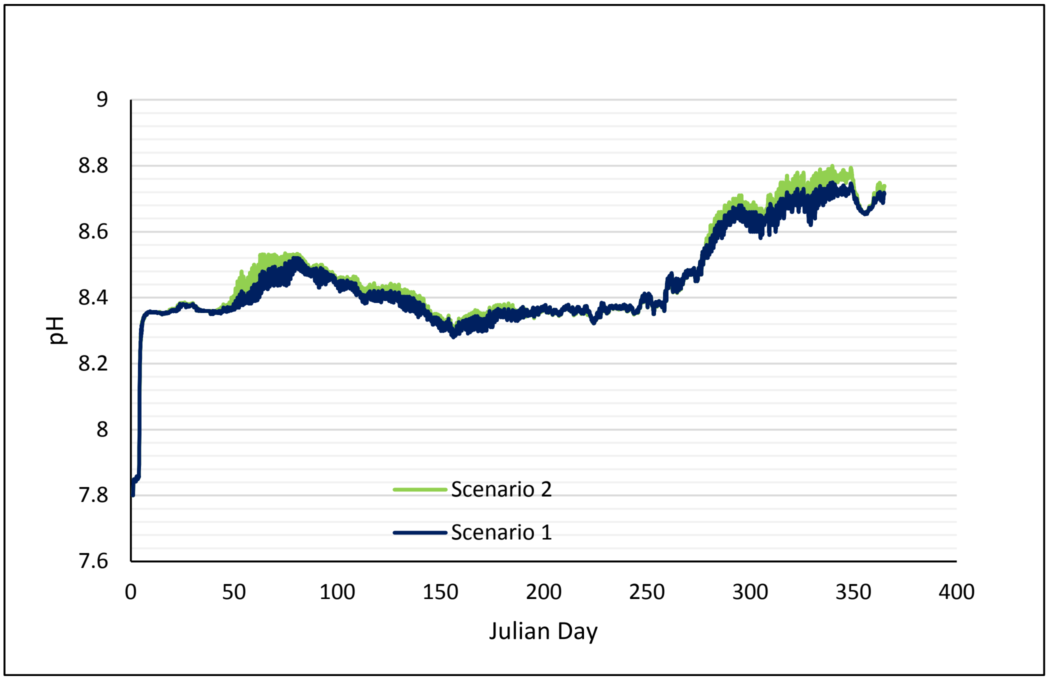

Figure 11. Model predicted pH at Albeni Falls Dam.

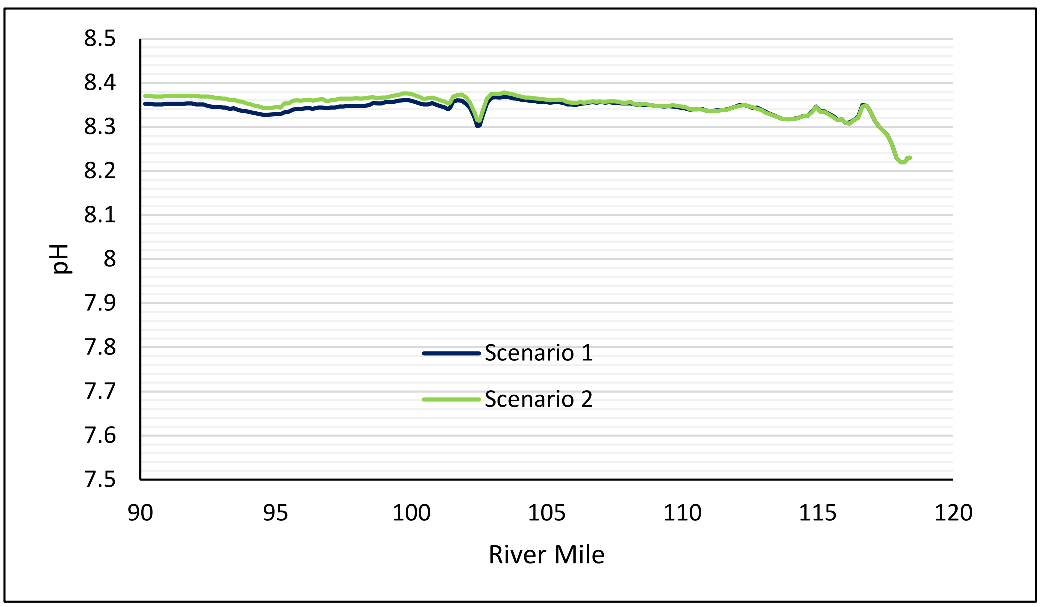

Figure 12. Longitudinal profile of pH on July 3rd at 4 pm (Julian Day 184.625).

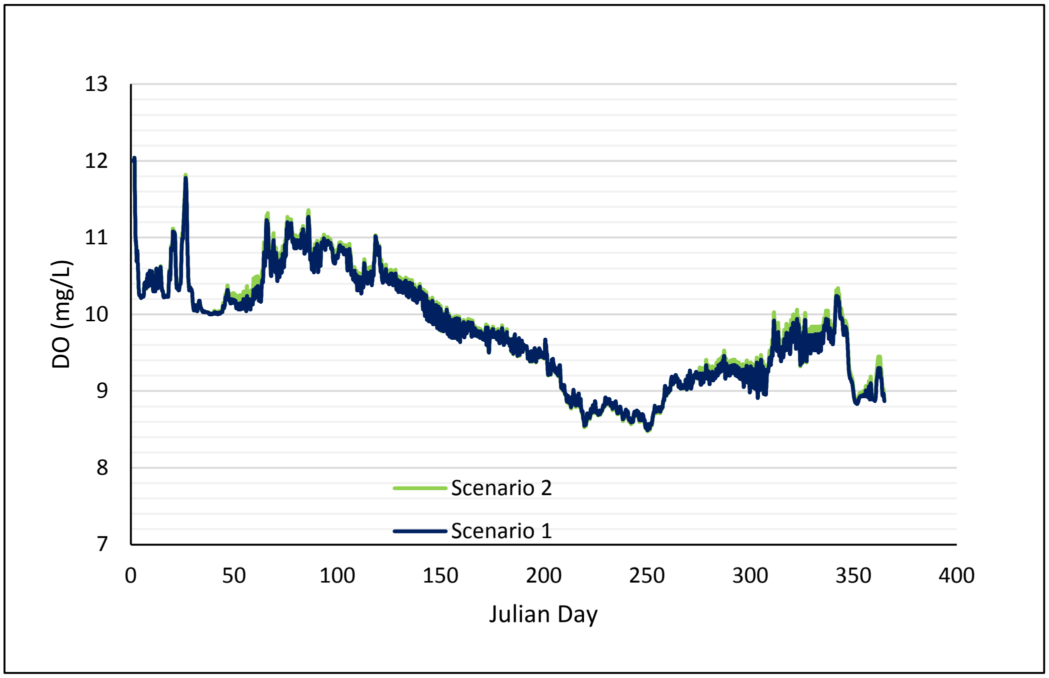

Figure 131. Model predicted dissolved oxygen 10 km downstream of upstream boundary.

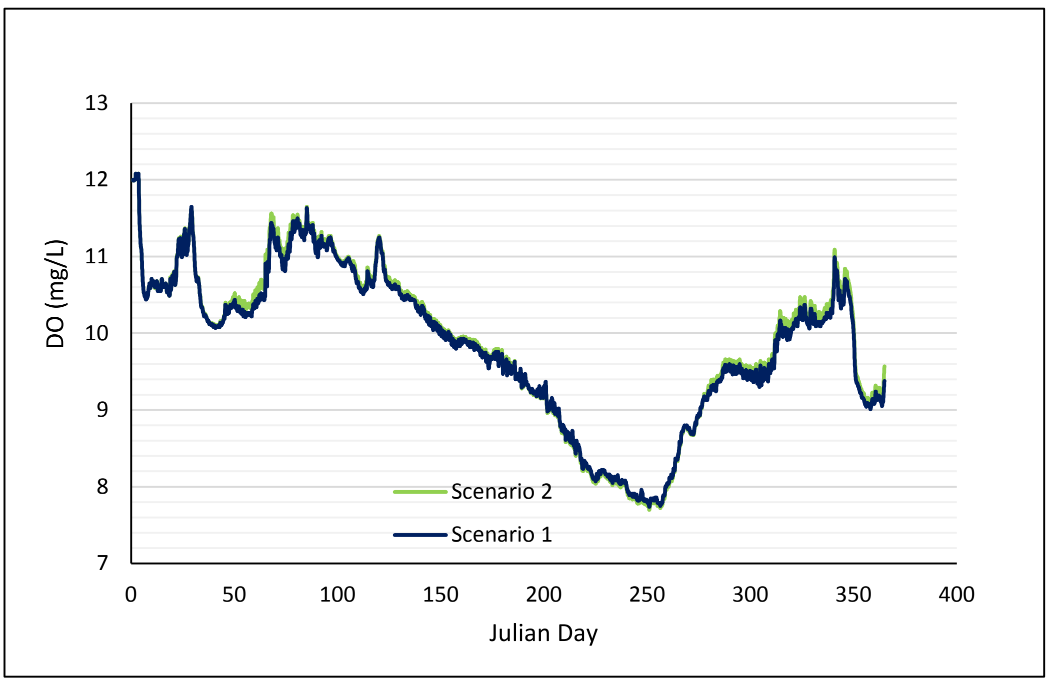

Figure 24. Model predicted dissolved oxygen 35 km downstream of upstream boundary.

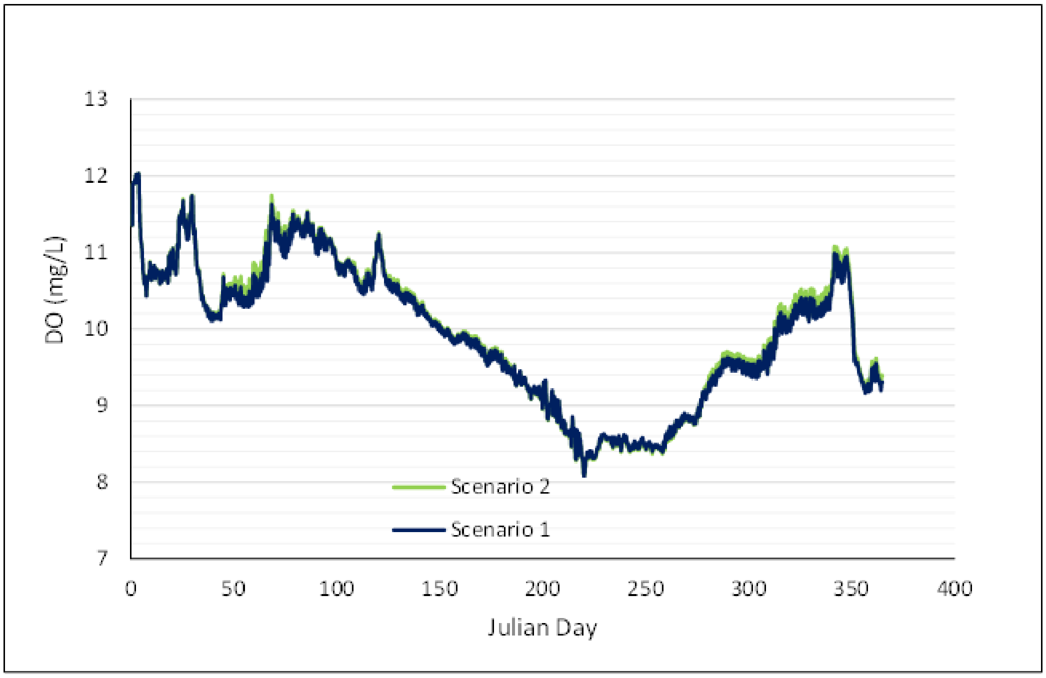

Figure 35. Model predicted dissolved oxygen at Albeni Falls Dam.

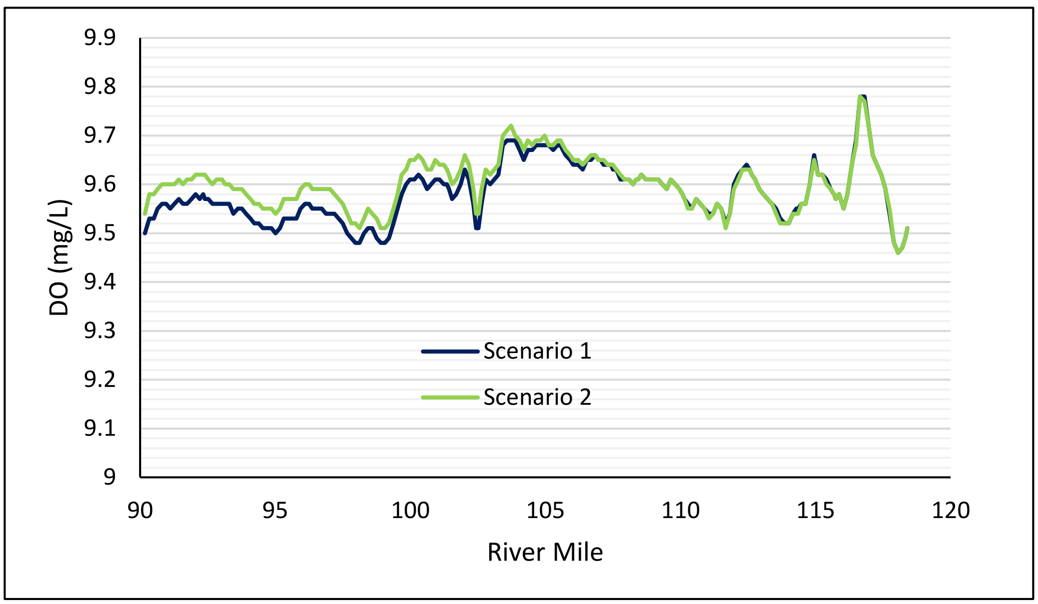

Figure 46. Longitudinal profile of dissolved oxygen on July 3rd at 4 pm (Julian Day 184.625).

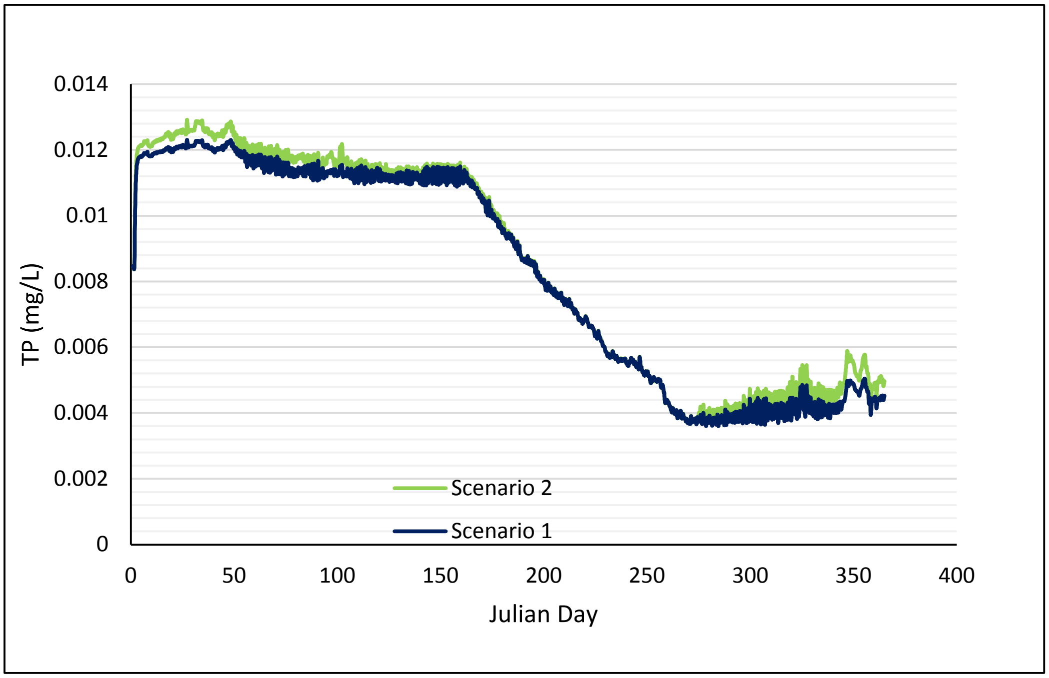

Figure 17. Model predicted total phosphorus concentration 10 km downstream of upstream boundary.

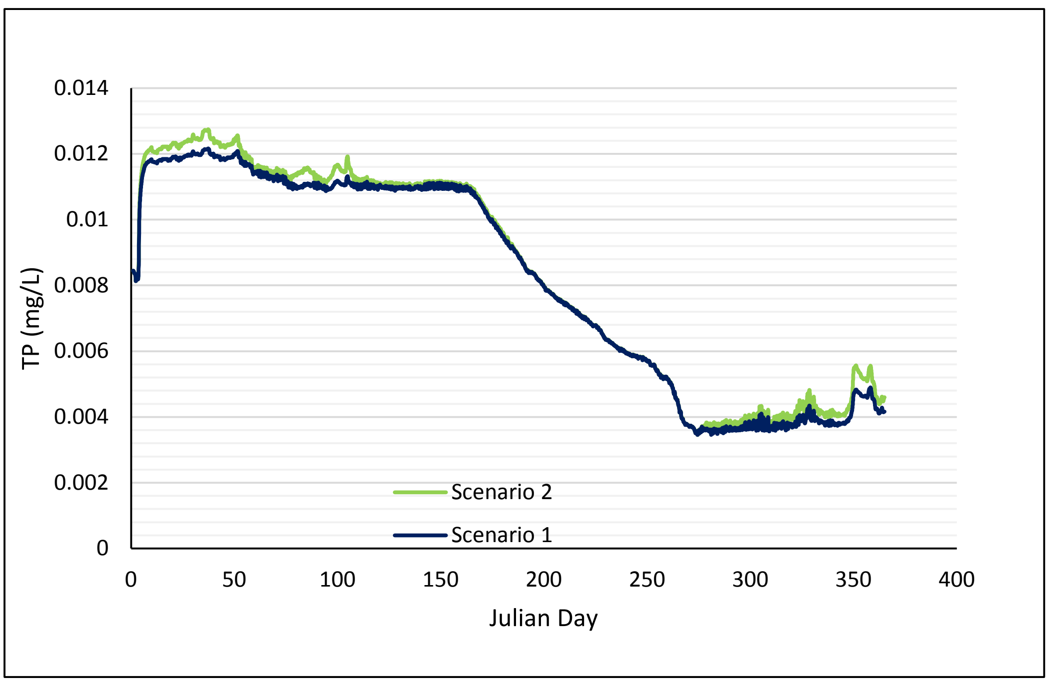

Figure 18. Model predicted total phosphorus concentrations 35 km downstream of upstream boundary.

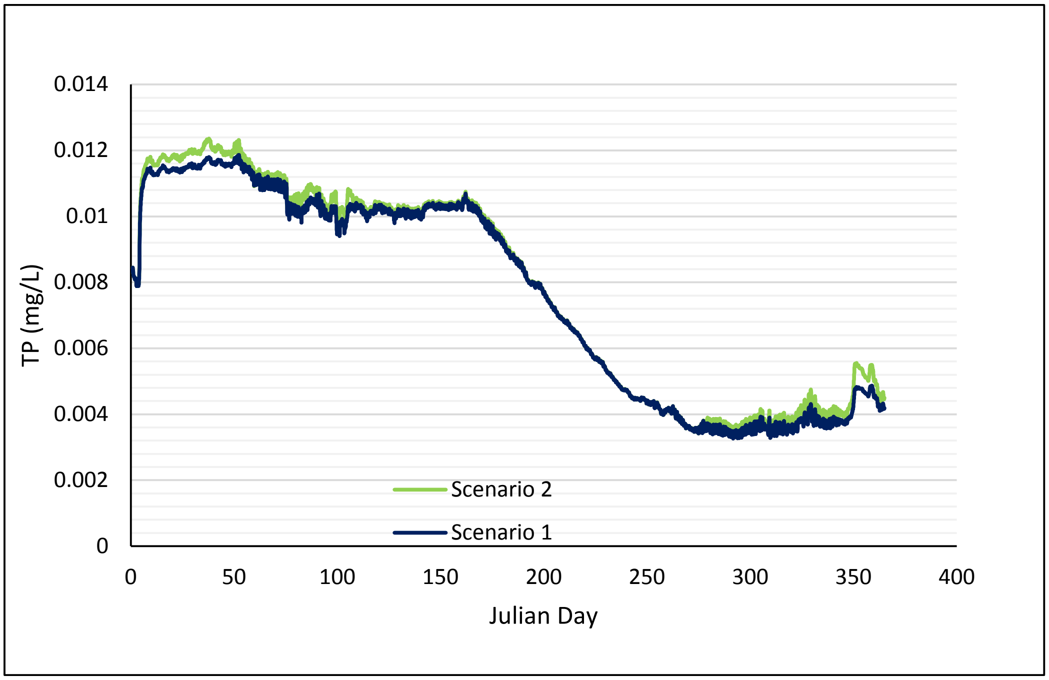

Figure 19. Model predicted total phosphorus concentration at Albeni Falls Dam.

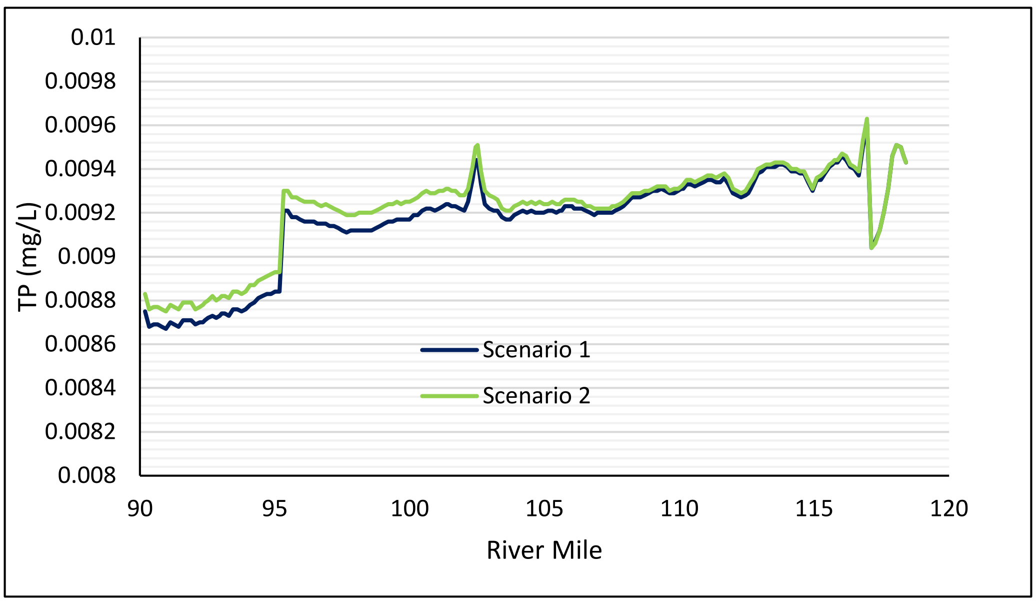

Figure 50. Longitudinal profile of total phosphorus concentration on July 3rd at 4 pm (Julian Day 184.625).

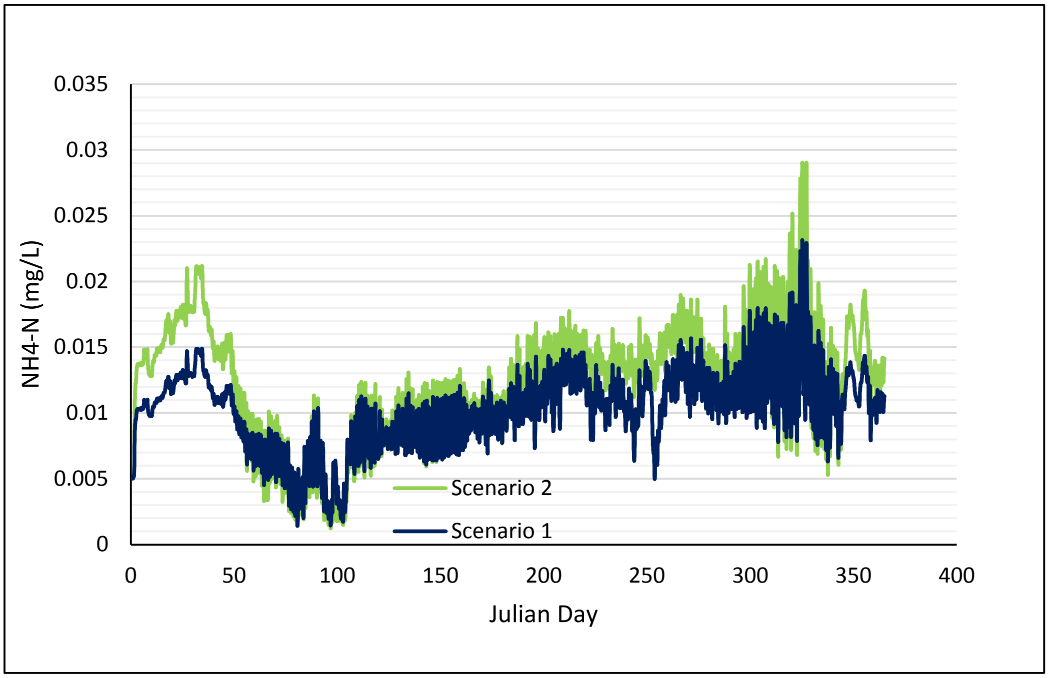

Figure 61. Model predicted ammonia nitrogen concentrations 10 km downstream of upstream boundary.

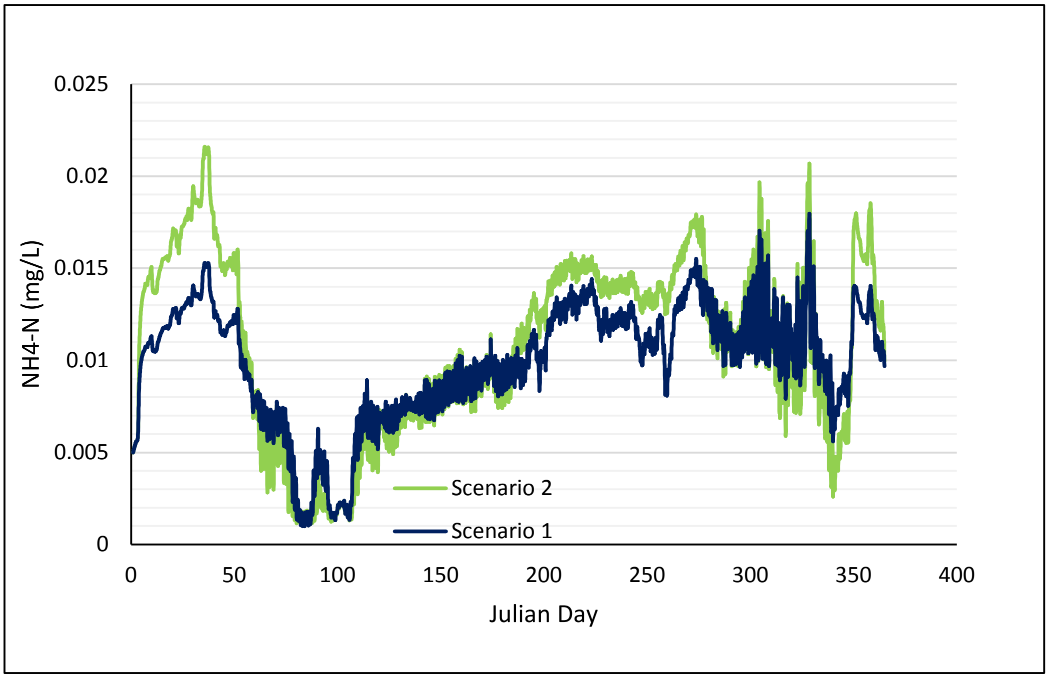

Figure 72. Model predicted ammonia nitrogen concentrations 35 km downstream of upstream boundary.

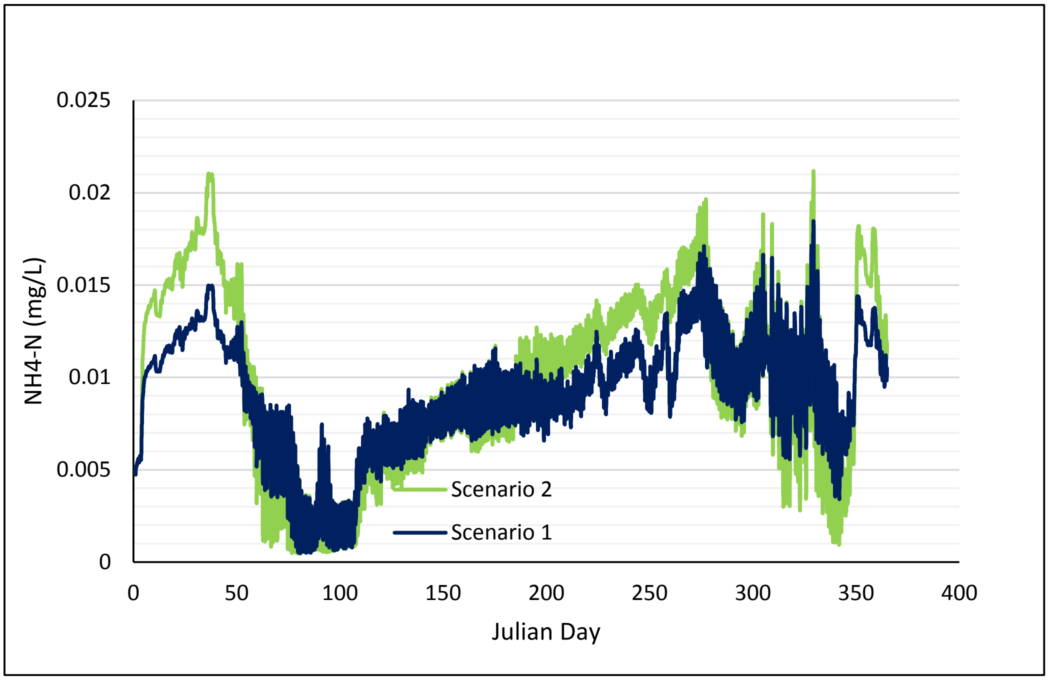

Figure 23. Model predicted ammonia nitrogen concentrations at Albeni Falls Dam.

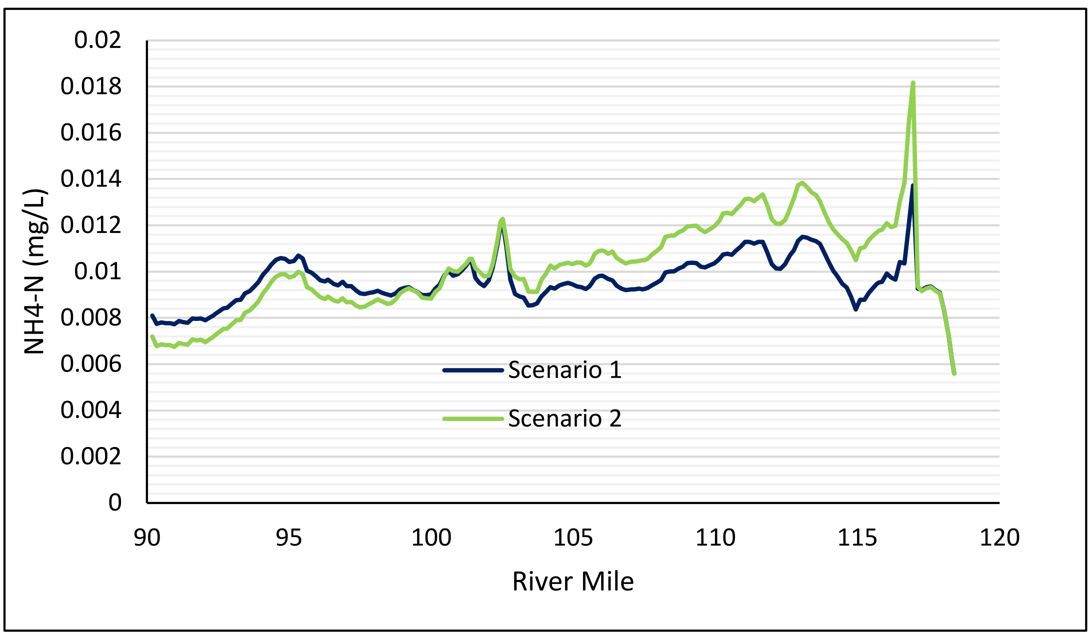

Figure 84. Longitudinal profile of ammonia nitrogen concentrations on July 3rd at 4 pm (Julian Day 184.625).

References

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